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PROCEEDINGS
OF
THE ROYAL SOCIETY.

1835-1836.

No. 24.

February 25, 1836.

HENRY HOLLAND, M.D., Vice-President, in the Chair.

A paper was read, "On an artificial Substance resembling Shell; by Leonard Horner, Esq., F.R.S. L and Ed.: with an account of the examination of the same; by Sir David Brewster, K.H., LL.D., F.R.S., &c."

The author, having noticed a singular incrustation on both the internal and external surfaces of a wooden dash-wheel, used in bleaching, at the Cotton Factory of Messrs. J. Finlay and Co., at Catrine, in Ayrshire, instituted a minute examination of the properties and composition of this new substance. He describes it as being compact in its texture, of a brown colour, and highly polished surface, with a metallic lustre, and presenting in some parts a beautiful iridescent appearance: when broken, it exhibits a foliated structure. Its obvious resemblance, in all these respects, to many kinds of shell, led the author to inquire into its intimate mechanical structure, and into the circumstances of its formation. He found, by chemical analysis, that it was composed of precisely the same ingredients as shell; namely, carbonate of lime and animal matter. The presence of the former was easily accounted for; as the cotton cloths which are placed in the compartments of the wheel, in order that they may be thoroughly cleansed by being dashed against its sides, during its rapid revolutions, have been previously steeped and boiled in lime water. But it was more difficult to ascertain the source of the animal matter; this, however, was at length traced to the small portion of glue, which, in the factory where the cloth had been manufactured, was employed as an ingredient in forming the paste, or dressing, used to smooth and stiffen the warp before it is put into the loom. These two materials, namely lime and gelatine, being present in the water in a state of extreme division, are deposited very slowly by evaporation; and thus compose a substance which has a remarkable analogy to shell, not only in external appearance, and even pearly lustre, but also in its internal foliated structure, and which likewise exhibits the same optical properties with respect to double refraction and polarizing powers.

A letter from Sir David Brewster, to whom the author had sub-

mitted for examination various specimens of this new substance, is subjoined; giving an account of the results of his investigations of its mechanical and optical properties. He found that it is composed of laminæ, which are sometimes separated by vacant spaces, and at others, only slightly coherent; though generally adhering to each other with a force greater than that of the laminæ of sulphate of lime, or of mica; but less than those of calcareous spar. When the adhering plates are separated, the internal surfaces are sometimes colourless, especially when these surfaces are corrugated or uneven; but they are almost always covered with an iridescent film of the most brilliant and generally uniform tint, which exhibits all the variety of colours displayed by thin plates or polarizing laminæ. This substance, like most crystallized bodies, possesses the property of refracting light doubly; and, as in agate and mother-of-pearl, one of the two images is perfectly distinct, while the other contains a considerable portion of nebulous light, varying with the thickness of the plate, and the inclination of the refracted ray. Like calcareous spar, it has one axis of double refraction, which is negative; and it gives, by polarized light, a beautiful system of coloured rings. It belongs to the rhombohedral system, and, as in the *Chaux carbonatée basée* of Haüy, the axis of the rhombohedron, or that of double refraction, is perpendicular to the surface of the thin plates. As mother-of-pearl has, like arragonite, two axes of double refraction; this new substance may be regarded as having the same optical relation to calcareous spar that mother-of-pearl has to arragonite.

The flame of a candle, viewed through a plate of this substance, presents two kinds of images; the one bright and distinct, the others faint and nebulous, and having curvatures, which vary as the inclination of the plate is changed: the two kinds being constituted by oppositely polarized pencils of light. On investigating the cause of these phenomena, Sir David Brewster discovered it to be the imperfect crystallization of the substance; whence the doubly refracting force separates the incident light into two oppositely polarized pencils, which are not perfectly equal and similar. In this respect, indeed, it resembles agate, mother-of-pearl, and some other substances; but it differs from all other bodies in possessing the extraordinary system of composite crystallization, in which an infinite number of crystals are disseminated equally in every possible azimuth, through a large crystalline plate; having their axes all inclined at the same angle to that of the larger plate, and producing similar phenomena in every direction, and through every portion of the plate: or this remarkable structure may be otherwise described, by saying that the minute elementary crystals form the surfaces of an infinite number of cones, whose axes pass perpendicularly through every part of the larger plate.

An examination of the phenomena of iridescence afforded by this new substance, leads him to the conclusion that the iridescent films are formed at those times when the dash-wheel is at rest, during the night, and that they differ in their nature from the rest of the substance. These phenomena illustrate in a striking manner some ana-

logous appearances of incommunicable colours presented by mother-of-pearl, which had hitherto baffled all previous attempts to explain them ; but which now appear to be produced by occasional intermissions in the processs by which the material of the shell is secreted and deposited in the progress of its formation.

March 3, 1836.

The Rev. WILLIAM WHEWELL, M.A., Vice-President, in the Chair.

The Right Hon. the Earl of Minto and Joshua Field, Esq., were elected Fellows of the Society.

A paper was read, entitled, "Researches on the Tides. Fifth Series: On the Solar Inequality, and on the Diurnal Inequality of the Tides at Liverpool." By the Rev. William Whewell, F.R.S., Fellow of Trinity College, Cambridge.

The inequality both in the height and time of high water in the morning and evening tides of the same day, which varies according to a law depending on the time of the year, is termed by the author *the diurnal inequality*, because its cycle is one day. The existence of such an inequality has often been noticed by seamen and other observers ; but its reality has only recently been confirmed by regular and measured observations ; and its laws have never as yet been correctly laid down. The author gives an account of the observations now in progress at different ports, from which he expects they will be ascertained with great precision. He traces the correspondence of the observations of the diurnal inequality already made with the equilibrium theory ; and remarks that the semi-diurnal tides, alternately greater and less, which are transmitted from the Southern Ocean to Liverpool, may be compared to the oscillations of a fluid mass : and that they are augmented by the action of the forces occurring at intervals equal to those of the oscillations. Hence the oscillations go on increasing for a considerable period after the forces have gone on diminishing, and reach their maximum a week after the forces have passed theirs.

The remaining sections of this paper are devoted to the investigation of the Solar inequalities at Liverpool. By carefully eliminating the Lunar effects, which the author is enabled to do by the aid of the preceding researches, he has determined the approximate circumstances of the Solar correction for the height. He has also obtained evidence of the existence, and some knowledge of the laws of the Solar inequalities of the times ; and these inequalities, as thus discovered, are found to exhibit the same general agreement with the equilibrium theory which has been disclosed in all the inequalities hitherto detected. The results of the extensive observations now obtained are sufficiently precise to indicate the defects of our mathematical theories of hydrodynamics ; and some of these are pointed out by the author, who remarks that although a short time ago the theory